United States Air Force
Scientific Advisory Board

Report on

Technology for Machine-to-Machine Intelligence, Surveillance, and Reconnaissance Integration

Volume 1: Executive Summary and Brief (PR)
SAB-TR-03-03
July, 2003

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Executive Summary

As modern warfare evolves, the value of pervasive awareness and rapid response on the battlefield increases. Current Air Force systems are highly capable, and within individual domains, are highly automated. If the real-time machine-to-machine interactions that facilitate the presentation of actionable, decision-quality information to the warfighter in an intuitive form is assured, then many manual steps can be eliminated.

The focus of this study was to understand the underlying reasons for the current lack of broad-based machine-to-machine intelligence, surveillance, and reconnaissance integration (MTMISRI), discover available actions to remove technology as an obstacle, and construct specific suggestions on how the Air Force might move toward more pervasive MTMISRI.

In the process of the study, ten hypotheses on the origins of the problem were posed:

1. Requirements: Needs were not identified when systems were acquired.
2. Acquisition – Either the wrong technology was purchased or the needed technology could not be purchased.
3. Technology – Key technologies were not available.
4. Resources – The solution is known but unfunded.
5. Training – The capability exists in current systems but is unused.
6. Communications –The data cannot get to where it is needed.
7. Security Policy – Security policy barriers prevent success.
8. "Tribal" Issues – Cultural and/or political barriers impede success.
9. Organization – Organizational barriers impede success.
10. ROE – Manual action and/or decision is a required process step.

While evidence to support each of these hypotheses as elements of the problem was found, consensus was reached on an eleventh hypothesis – that the lack of an overarching architecture for intelligence, surveillance, and reconnaissance (ISR) severely inhibits integration and is the major obstacle to widespread MTMISRI.

Many disparate efforts are successfully integrating ISR systems to realize high priority machine-to-machine connectivity. For the most part, these efforts should not stop! However, these activities, while useful individually, will make it harder to achieve the vision of quickly integrating new and pre-existing systems to take advantage of shared information.

There are three major findings of the study:

1. The Air Force has no commonly accepted architectural framework to achieve MTMISRI.
2. The Air Force must revise security policy to achieve a better balance between "protection" and "usability."
3. The Air Force should make sensor data from unconventional sources readily available as part of the ISR-data stream.

Making machines "talk" to each other is difficult, especially since competing companies designed them independently, to divergent requirements, with less-than-crisp interface specifications, and in different eras. Each domain ("stove-pipe") is currently doing its best to integrate its systems by identifying deficiencies, prioritizing them, and funding fixes to as many deficiencies as it can locally afford. This has produced collections of high value, locally (pair-wise) connected systems that are globally disconnected and difficult to integrate.

The end result is that there is no single ISR architecture, but rather many architectures that evolved to meet specific requirements and remain largely incompatible.

The Study Committee believes there are four basic architecture options to correct the MTMISRI deficiencies. In all cases, the cost to retrofit and integrate existing systems into a new architecture drives the total ownership cost.

The Study Committee makes five recommendations:

1. Fund a program to achieve ISR/Operations integration. Include as part of the program:
    a. Building a modern technical architecture and the associated enterprise services infrastructure;
    b. Validating the architecture and associated infrastructure through experiments;
    c. Authority over other programs to enforce compliance with the architecture;
    d. Central funding for infrastructure and retrofit/integration of existing systems;
    e. Development of a test and certification capability to support the compliance mandate;
    f. Support for revisions of concepts of operations (CONOPS) and doctrine that result from program successes;
    g. Development of a program schedule that supports an initial operating capability (IOC) no later than that of the Air Force Distributed Common Ground System (AF DCGS) Block 10.2 Program and demonstrates an interim reference architecture at the Joint Expeditionary Force Experiment 2006(JEFX-06); and
    h. A definition of an IOC that will assure the ability to seamlessly exchange information among a specific set of domains.
2. Establish a policy that mandates compliance with the architecture. Use experimentation as the route to confidence-building demonstrations prior to enforcing the policy.
3. Engage the Intelligence Community (IC) to:
    a. Focus on CONOPS, doctrine, and policy for strategic and operational information sharing and collection management;
    b. Review and revise classification and releaseability guidelines while striving to achieve a balance between "protection" and "usability"; and

c. Integrate Air Force MTMISRI activities with the Horizontal Integration Initiative proposed by the Transformational Space and Air Program (TSAP).

4. Institute enterprise data management in each of the Air Force's major domains (the Air Mobility Command provides a good example), to focus on:

   a. Semantic agreement;

   b. Metadata registry;

   c. Data ownership/sharing; and

   d. Data management across domains.

5. Incorporate responsive access to non-traditional sources as part of ISR/Operations integration.

The Study Committee found that while some technological challenges exist to MTMISRI, they are not insurmountable. Significant changes in program management of MTMISRI will make it a reality for the Air Force.

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Integrity - Service - Excellence

Technology for Machine-to-Machine ISR Integration (MTMISRI)

Study Outbriefing

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Study Charter

- **Understand** the evolution, current state, and capabilities of existing and planned ISR systems and their interfaces and integration with Command and Control (C2) systems that are relevant to the real-time combat environment.
- **Provide insight into technology and process steps that the Air Force should take** to achieve real-time information integration into a single real-time product across system, geographic, and cultural boundaries.
- **Identify new opportunities** to take traditionally unrelated information sources and integrate them in ways that exploit the power of the machine at the digital level while requiring little or no human intervention.
- **Propose a near term experiment** using existing Air Force systems that can demonstrate MTM integration and serve as a beginning to a longer term process.

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Study Members

SAB Members

Wanda Austin	Space Systems
Doc Dougherty (Chair)	C4ISR and Systems Technology
Tom Garvey	C2 and Information Systems
Dan Held	ISR Systems Development
Lou Metzger	C4ISR and Systems Technology
LtGen (R) George Muellner	AF Ops and Acquisition
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LtGen (R) Linc Faurer	Intel Systems and Operations
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Maj Carol Welsch	Study Technical Advisor
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Capt Kent Broome	SAB Study Executive Officer

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Visits/Briefings

- CIA
- NIMA
- NSA
- L3Com (Rockwall TX)
- L3Com (Greenville TX)
- Raytheon (Garland TX)
- ESC
- AlphaTech (Burlington MA)
- NRO
- Northrop Grumman (Baltimore)
- 7th Air Force
- 12th Air Force
- PACAF
- Boeing
- Lockheed
- DARPA
- SIAP
- Dep NSSI
- AMC
- Army CIO – LGen(S) Boutelle
- Navy ForceNet
- AF/XI –
  LtGen Kenne
  BGen Goodrich
  SES David Tillotson
- AF CIO – SES John Gilligan
- AF/XOQ – SES Snake Clark

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The Problem

- We can do much to eliminate manual steps by assuring that real-time MTM interactions facilitate:
  - ✓ Presentation of actionable decision quality information
  - ✓ to the warfighter
  - ✓ in an intuitive form
  - ✓ as it is needed
- We have sought:
  - ✓ The underlying reasons for the current lack of MTMISRI
  - ✓ Available actions to remove technology as an obstacle
  - ✓ Specific suggestions on how to move toward MTMISRI

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10 Hypotheses Why We Don't Currently Have MTMISRI

1. **Requirements – needs not identified when systems were acquired**
2. **Acquisition – bought the wrong stuff; couldn't buy the right stuff**
3. **Technology – key technologies are not available**
4. **Resources – the solution is known but unfunded**
5. **Training – capability exists (unused) in current systems**
6. **Communications – can't get the data to where it is needed**
7. **Security Policy – security policy barriers prevent success**
8. **"Tribal" Issues – cultural/political barriers impede success**
9. **Organization – organizational barriers impede success**
10. **ROE – manual action/decision is a required process step**

What is the relative importance of each hypothesis?

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Things We Didn't Address

- Joint / Coalition issues
- Acquisition system
- Adequacy of communications
- Adequacy of collection assets

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The Bottom Line at the Top

- There is no commonly accepted architectural framework on which to hang machine-to-machine ISR integration
- If you want to fix this problem, treat it as a program!

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One Preliminary

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Domain-Specific Architectures

- The MTM problem exists across many domains, e.g.:
  - ✓ Defense suppression, ISR,
  - ✓ Air Defense, Combat Ops,
  - ✓ Mobility, Logistics, …

Domains: Collaborative groups of users who must exchange information in pursuit of their shared goals, interests, missions, or business processes, and who therefore must have shared definitions for the information they exchange

- Within each of the ISR domains, we found people:
  - ✓ Identifying deficiencies
  - ✓ Prioritizing them
  - ✓ Funding as many as they can locally afford
- The result is collections of high value, locally (pair-wise) connected systems that are globally disconnected and increasingly difficult to integrate

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The Core of The Problem

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The Architecture Is Missing

- There is no overarching ISR architecture, but rather *many architectures*
  - ✓ Evolved to meet specific requirements
  - ✓ Remain largely incompatible
  - ✓ Will not converge on their own
- Control mechanisms are disparate and fragmented
- We believe there are four basic options:

  Note: Retrofit and integration of existing systems into a new architecture drives total cost

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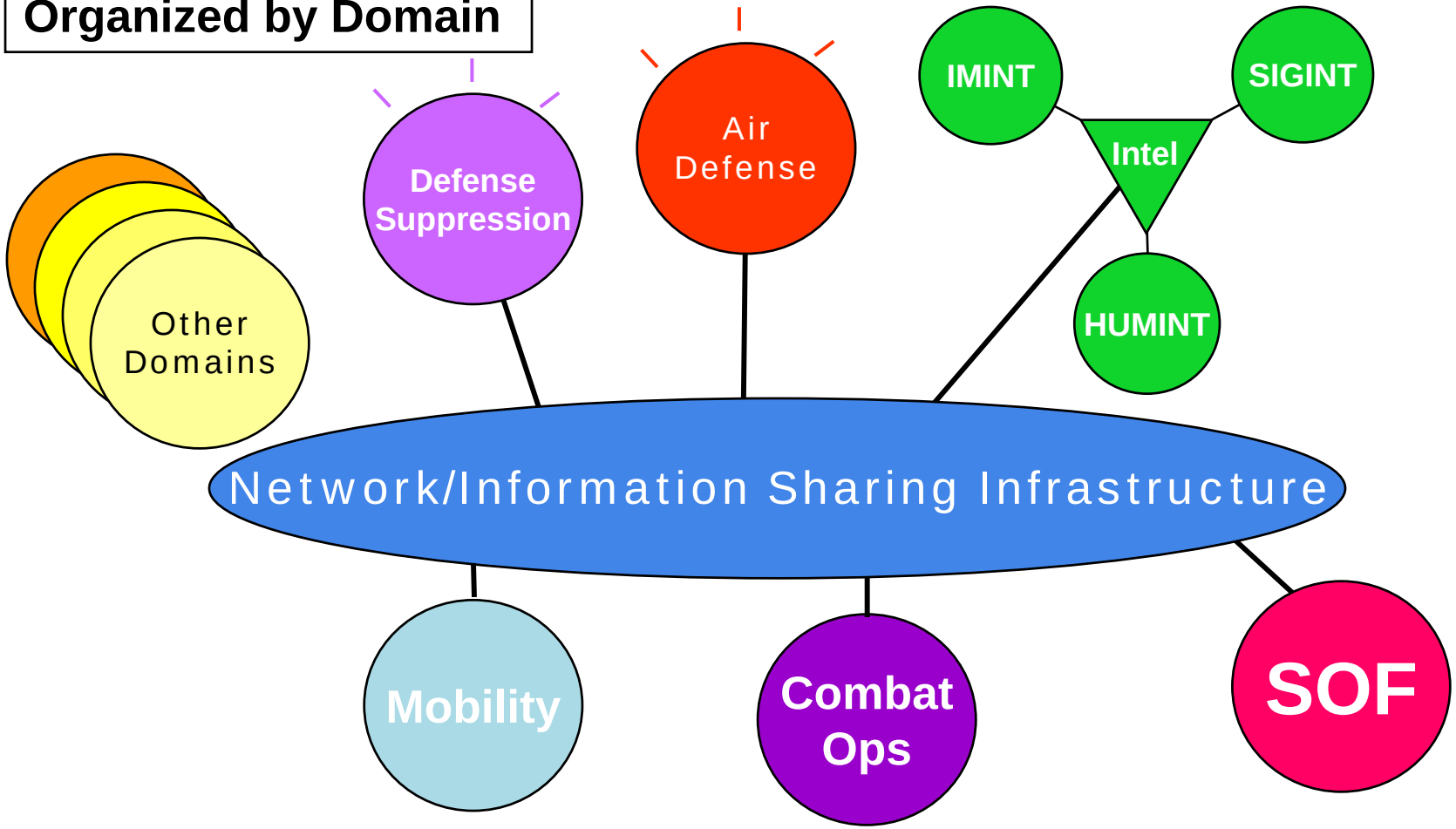
Unifying the Tribes:
Exploit the Existing Domains

A Federated Network Organized by Domain



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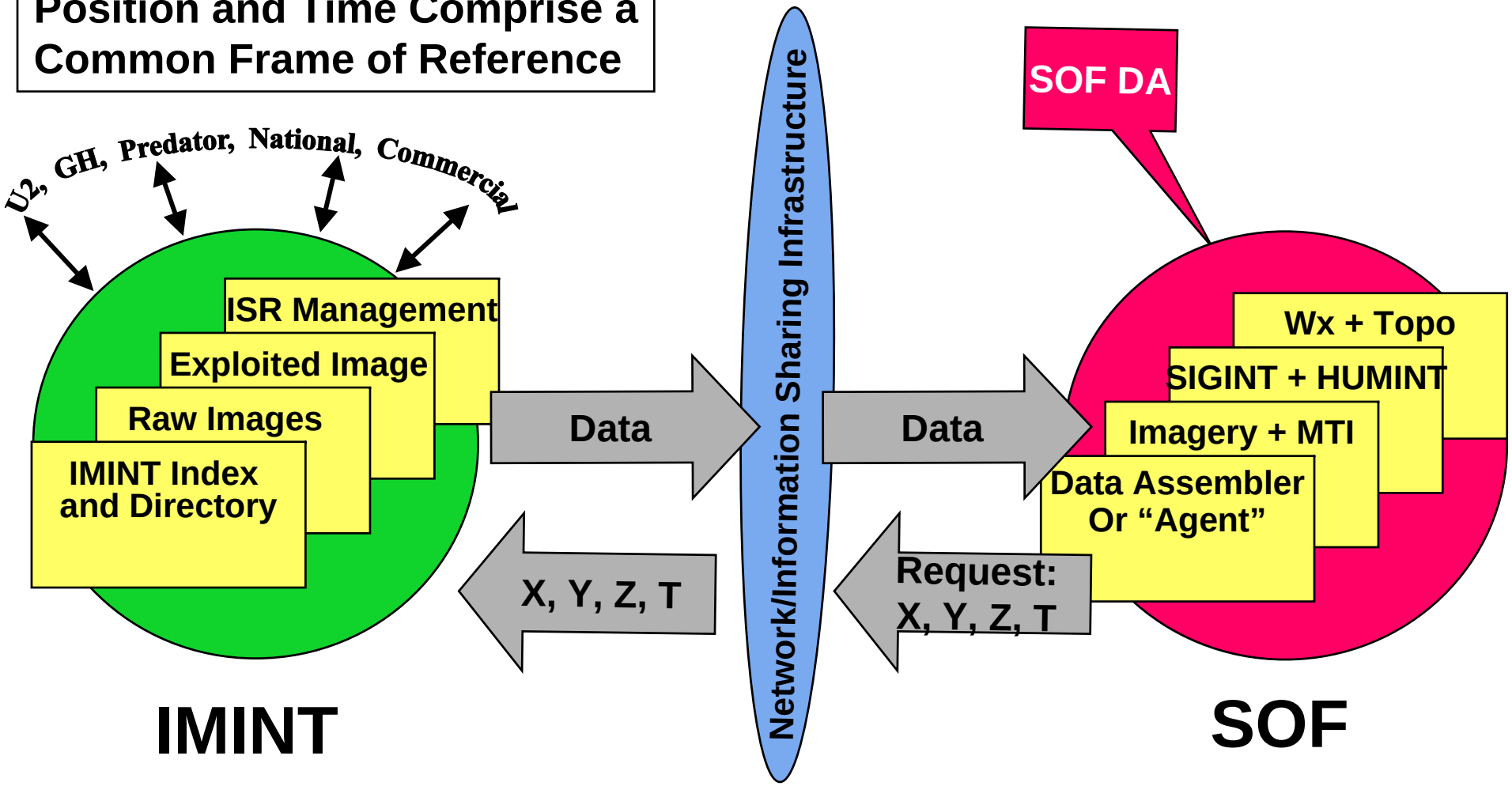
Example of a Transaction: SOF Request Situational Awareness

Position and Time Comprise a Common Frame of Reference



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Recommendations

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Recommendation 1 (in two parts): Commit

In order for MTM interaction to drive ISR/Operations integration:

- CSAF must commit to -
  - ✓ Fund a program to include implementing an architecture and the associated infrastructure
  - ✓ Establish a policy that mandates compliance with the architecture

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1A – Fund a Program

- Centrally fund
  - ✓ Enterprise services-based architecture and infrastructure
  - ✓ Retrofit and integration of existing systems
- Include authority over other programs to enforce compliance with the architecture
- Build a test and certification capability to support the compliance mandate
- Validate the architecture and associated infrastructure through experiments
- Support revision of CONOPS and doctrine that result from program successes
- Develop a program schedule that supports an IOC no later than DCGS 10.2 and demonstrate an interim reference architecture at JEFX-06
  - ✓ Define IOC as the ability to seamlessly exchange information among a specific set of domains

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1B – Establish a Policy

- Publish a policy to provide advanced notice that architecture compliance will be required
- Validate the architecture before enforcing the policy:
  - ✓ Define the technical architecture
    - Leverage *popular* commercial standards
  - ✓ Get industry buy-in
  - ✓ Build the infrastructure needed to validate the architecture
  - ✓ Perform experiments which validate the architecture
  - ✓ Assure that a capability exists to perform certification testing of products that claim they conform to the architecture
- Enforce the policy

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Recommendation 2: Engage

- CSAF & SecAF engage the Intelligence Community (IC) to:
  - ✓ Focus on CONOPS, policy, and doctrine for strategic and operational information sharing and collection management
  - ✓ Review and revise classification and releaseability guidelines
    - Strive to achieve balance between "protection" and "usability"
    - Educate the IC on warfighters' *modus operandi* – now and in the future
  - ✓ Integrate AF MTMISRI activities with the HI Initiative proposed by the Transformational Space and Air Program (TSAP)

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Recommendation 3: Manage

- Institute enterprise data management in each of the Air Force's major domains (AMC provides a good example)
  - ✓ Semantic agreement
  - ✓ Metadata registry
  - ✓ Data ownership/sharing
- Develop data management across domains
  - ✓ Hierarchical communities of interest
  - ✓ Data mediation

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